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USER'S MANUAL FOR THE DIINS HUMAN-COMPUTER INTERFACE

ENGINEERING BUSINESS-CRITICAL
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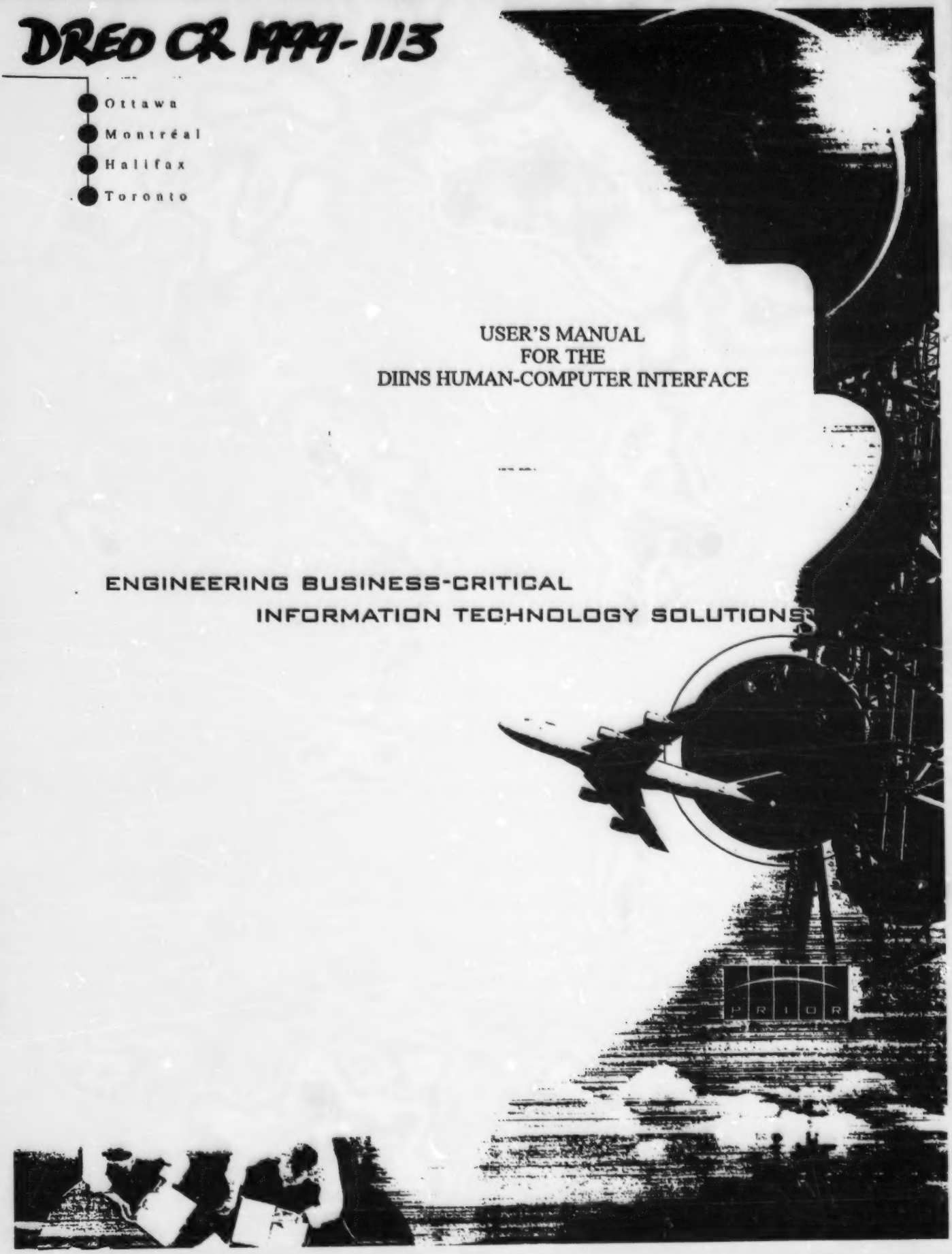

USER'S MANUAL
FOR THE
DIINS HUMAN-COMPUTER INTERFACE

PRIOR Document No.: 99-0067-K

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DIINS HUMAN-COMPUTER INTERFACE

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PRIOR Document No.: 99-0067-K

USER'S MANUAL
FOR THE
DIINS HUMAN-COMPUTER INTERFACE

Version 1.0

30 March 1999

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REVISION NOTES

VERSION	DATE	DESCRIPTION
1.0	March 30, 1999	First Draft

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1. SCOPE

1.1 Identification

This HCI User's Manual applies to the Human Computer Interface (HCI) CSCI associated with Dual Inertial Integrated Navigation System (DIINS) Advanced Development Model (ADM) program, described in Reference a). This User's Manual provides the procedures for operating the DIINS HCI and describes the intended use of the system. In addition, this manual also describes the SHINNADS display and SHINNADS-DIINS interface.

1.2 System Overview

The following project background information is reproduced from Reference b).

A need for an integrated navigation system for the Canadian Navy's major warships has existed for some time. Present navigation instruments on the ships operate independently and significant operator effort is required to monitor the navigation suite and determine the best estimate of the ship's true position. The Defence Research Establishment Ottawa (DREO) has conducted an extensive research and development program into the development of a DIINS system that integrates the data from the various on-board navigation sensors and automatically computes the best estimate of the ship's true position, speed, heading and attitude. At the same time the system monitors the health of the various sensors to determine even very subtle sensor abnormalities, and can reconfigure the sensor suite so that the navigation solution is not corrupted by faulty sensor data.

The DIINS developed at DREO has undergone extensive laboratory testing, dedicated sea trials aboard a research vessel, and an operational evaluation on one of the Navy's Halifax class frigates, HMCS Calgary. The current DIINS software consists of approximately 30,000 lines of Ada code, and the real-time hardware consists of 3 VME bus computer cards and associated components. A separate effort has led to the development of SHINNADS - the Shipboard Integrated Navigation and Display System. SHINNADS - which is being built by Offshore Systems Ltd. of Vancouver B.C. - is an ECDIS (Electronic Chart and Display Information System) that has been specially modified to operate in the navy environment. Now, the DIINS is to be designed and built to be inserted into the SHINNADS console in order to provide highly accurate and reliable navigation data to drive the electronic charts of SHINNADS.

1.3 Document Overview

This document has been prepared in response to the Human Computer Interface, Control and Display CSC description in DIINS ADM Development Software Design Document (Reference a).

This document is organized as follows:

Section 1 identified the scope of the document.

Section 2 provides a list of reference documents.

Section 3 describes the computer system operation.

Section 4 provides the information and instructions necessary to operate the HCI.

Section 5 describes the SHINNADS display of DIINS data.

Section 6 contains a list of acronyms used in the document.

Appendix A provides the list of exceptions se t from DIINS to HCI.

Appendix B includes the description of the interface providing DIINS data to SHINNADS.

2. REFERENCED DOCUMENTS

a) "DIINS ADM Development Software Design Document (SDD)", PRIOR Document No.: 98-0040-K, PRIOR Data Sciences Ltd., 15 June 1998.

b) "Request For Proposal, Dual Inertial Integrated Navigation", Solicitation No. W7714-6-0043 A, OBS Ref No. PW-SSSV-041-346.

c) "User's Guide to OS/2 Warp", IBM, January 1995.

3. SOFTWARE SUMMARY

3.1 Software Application

The user can interact with DIINS in two ways: via a PC or via SHINNADS display.

DIINS HCI is designed to run on a PC in an OS/2 environment. The PC can be a hand-held or laptop PC, or SHINNADS PC on the DIINS system. The PC is connected to DIINS via an available communication port. The HCI enables the user to view and optionally change some of the DIINS configuration and filter parameter files.

SHINNADS is an Electronic Chart and Display Information System that has been specially modified to operate in the navy environment. It receives data directly from DIINS and displays it on the console. See Appendix A for the description of the interface providing DIINS data to SHINNADS.

This document assumes that the user has some experience running IBM OS/2 applications. In particular, the user is familiar with the keyboard/mouse operations and window manipulations in an OS/2 environment. Reference c) provides a detailed description on manipulating windows and controls.

4. PROCESSING REFERENCE GUIDE

4.1 Processing Procedures

4.1.1 Starting DIINS HCI

The user starts the DIINS HCI by typing the name of the executable program at the OS/2 command prompt or by double-clicking the application icon. The user may specify the serial port to communicate with DIINS as the argument, especially if the port used differs from the default port, which is com10. When the HCI is started, the communication port is initialized.

4.1.2 The DIINS HCI Main Window

As the HCI starts, the HCI main window is created. The main window, as shown in **Figure 4-1**, contains a set of action buttons, and a message bar at the bottom of the window providing feedback to the user. The message "Diins HCI started" is displayed at startup. For most of the action buttons whose captions end with "...", selection of the button opens a form.

HCI has two modes: maintenance mode and operational mode. Most actions are designed to be undertaken by the trained maintenance personnel; therefore, some of the action buttons are hidden in the operational mode.

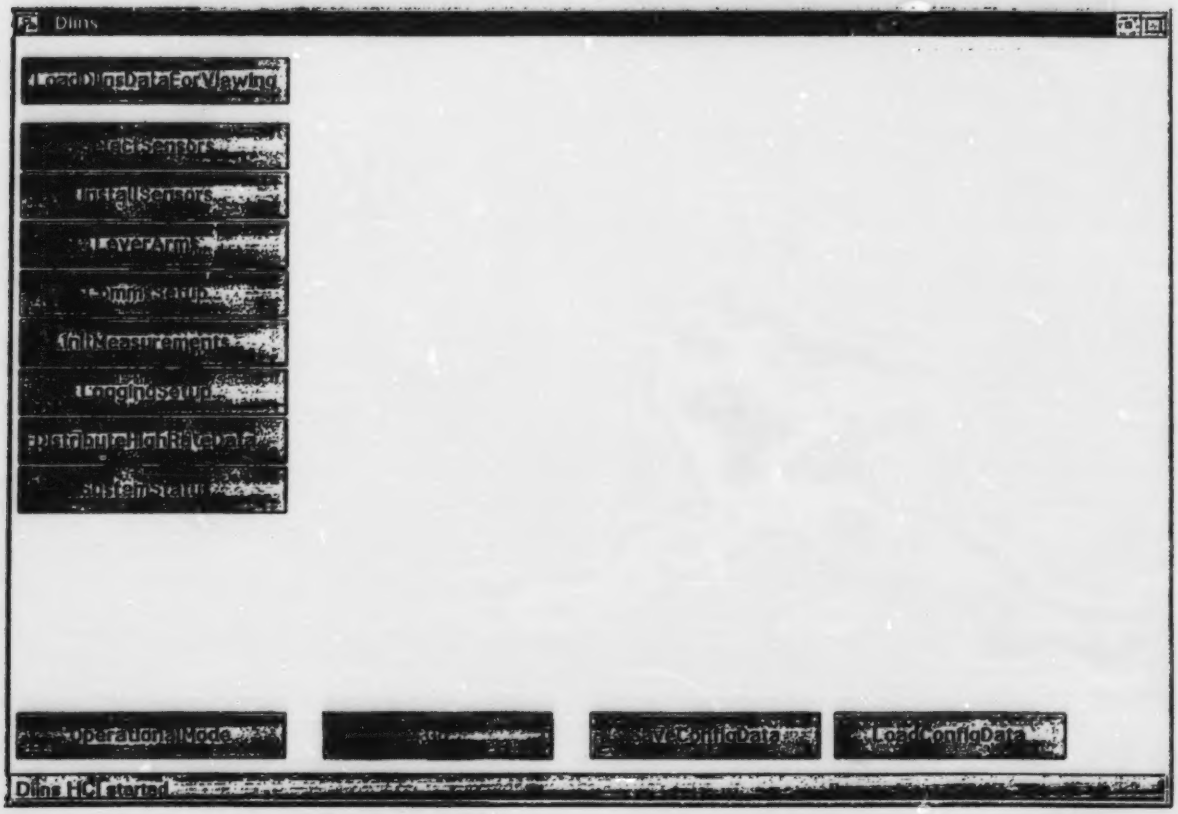

Figure 4-1 HCI Main Window

The action buttons are listed in **Table 4-1.**

Table 4-1 Main Window Buttons

Button	Description	Mode
LoadDiinsDataForViewing/Changing	Request DIINS to send configuration data	Maintenance/Operational
SelectSensors...	Open Select Sensors Form	Maintenance/Operational
InstallSensors...	Open Install Sensors Form	Maintenance
LeverArms...	Open Lever Arms Form	Maintenance
CommsSetup...	Open Communications Setup Form	Maintenance

Button	Description	Mode
InitMeasurements...	Open Installed Sensors List	Maintenance
LoggingSetup...	Open Data Logging Form	Maintenance
DistributingHighRate Data...	Open Distribute High Rate Data Form	Maintenance
SystemStatus...	Open System Status Form	Maintenance/Operational
Maintenance/ Operational Mode	Toggle Maintenance/Operational Modes	Maintenance/Operational
Go	Inform DIINS so that the changes by the user can take effect	Maintenance/Operational
SaveConfigData	Save the configuration data to a file	Maintenance/Operational
LoadConfigData	Load the configuration data from a file	Maintenance/Operational

4.1.3 Overview of the Operation Procedures

The HCI allows the user to access DIINS configuration parameters, to modify the data if necessary and to view the system events. Generally, HCI is started prior to DIINS. DIINS will send an "Init" message to HCI upon startup and wait for three minutes for any actions taken by the user. Within this starting period, the user has the opportunity to interrupt the start up of the DIINS. At the end this period, DIINS sends a "Started" message to the HCI and starts running.

Upon receiving the "Init" message, the HCI changes the caption of the Load button to "LoadDiinsDataForChanging" and shows a blue gauge indicating the time left in seconds (**Figure 4-2**). The user may select [LoadDiinsDataForChanging] button to load configuration data from DIINS. Once [LoadDiinsDataForChanging] button is selected, DIINS will clear the timeout timer and wait for the "Go" command from HCI. Outside the DIINS starting period, the Load Button shows "LoadDiinsDataForViewing".

A set of forms are provided to allow the user to view and change the data. Selecting the [OK] button on each form results in closing the form and sending changed data items to DIINS. However, the changes do not take effect until the user selects the [Go] button so that HCI sends a Go command to DIINS. Once DIINS is started, the [Go] button is dimmed since further Go command have no effect on DIINS execution. The [OK] buttons on most of the forms are also disabled. After DIINS has started running, on the other hand, the user may still select [LoadDiinsDataForViewing] button at any time to obtain the configuration parameters currently

in effect. DIINS sends the current CPU Load and any exceptions continuously to HCI. The System Status form allows the user to monitor these system events.

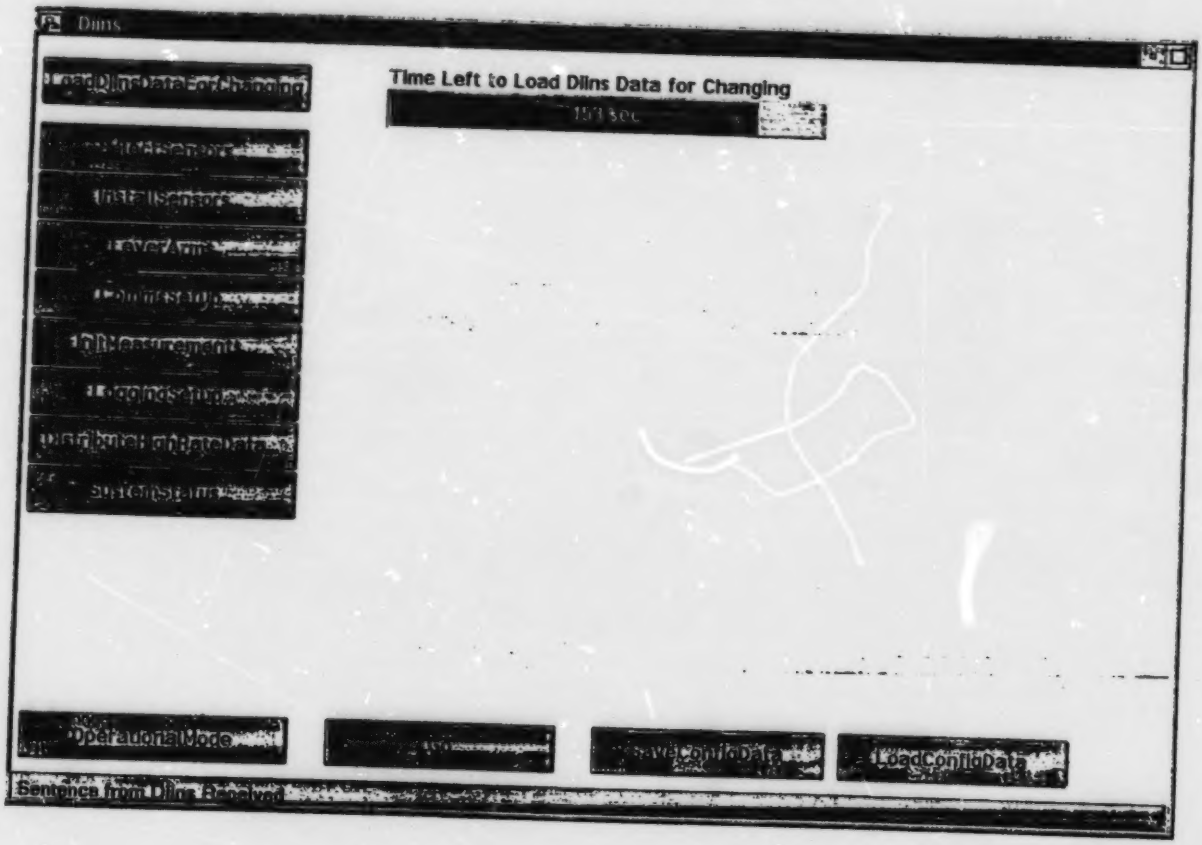

Figure 4-2 Timeout Indicator

The general features of windowing interface HCIs are available on the DIINS HCI. These include:

- Selection of list items via mouse clicks;
- Multiple selections by holding Shift key;
- Alphabetical finding of list entries by clicking on the list and entering the first letter of the item to be found;
- Scrolling up and down list items, and their associated data items using the keyboard arrow keys; and
- Tabbing between the various fields presented on the forms using the keyboard "Tab" key.

A Cancel button is present on all the forms. Selecting Cancel closes the form. Any changes of data on the form will be discarded.

4.1.4 Mode Button

The mode Button switches between maintenance and operational mode. Selecting this button makes the actions associated with that mode visible. In addition, a message is displayed on the message bar to show the current mode. All the actions are available in Maintenance mode. While in Operational mode, only the LoadDiinsDataForViewing/Changing, SelectSensors, SystemStatus, and Go buttons are present.

4.1.5 Selecting Sensors

The Select Sensors form, shown in **Figure 4-3**, allows the operator to select which sensors will be used to generate the navigation solution using DIINS. Only the sensors previously physically installed and installed in the software using the Sensor Installation Form (**Figure 4-4**) show up as being available for selection for the navigation solution.

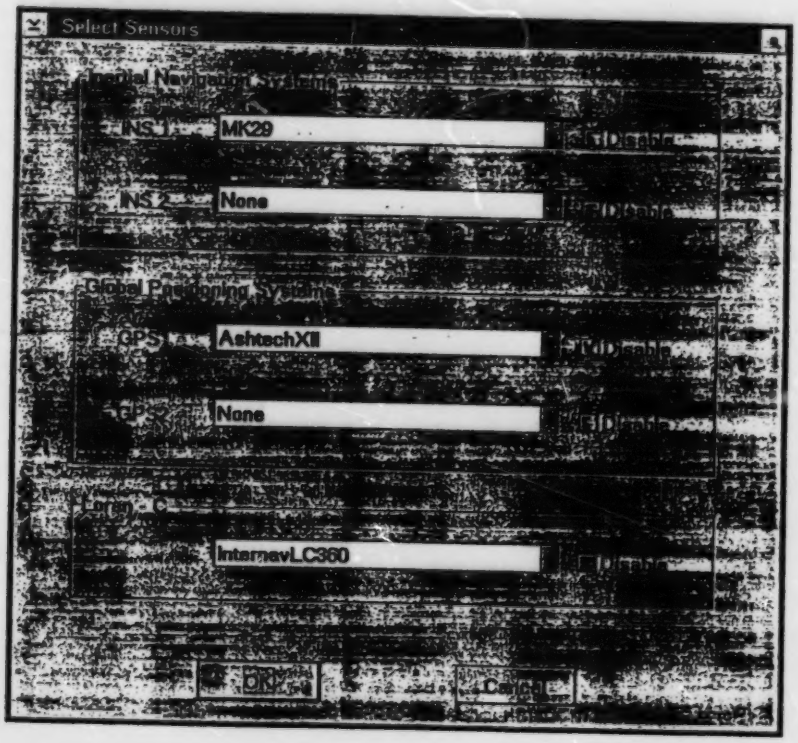

Figure 4-3 Select Sensors Form

4.1.5.1 Selecting Sensor From Sensor Lists

On the Select Sensors form, five combo boxes are present, corresponding to the five sensor types: INS1, INS2, GPS1, GPS2 and LORAN-C. Each combo box contains a list of installed sensor models associated with the sensor type. The selected sensor model name is displayed in the box. The user selects a sensor model for each type of sensor and presses the [OK] button to send the list of the selected sensors to DIINS. In general, this only happens during the DIINS starting period.

4.1.5.2 Disabling And Enabling Sensors

The check boxes beside the combo boxes provide the user with the option of temporarily disabling a selected sensor. Check the box (a check mark will appear) to disable the sensor shown in the combo box on the right of the check box. In **Figure 4-3**, for example, the sensor model Ashtech XII is disabled while MK29 and InternavLC360 are enabled. When this form is used to disable/enable sensors, selecting [OK] results in sending the changed sensor (disabled/enabled) states.

4.1.6 Installing Sensors

The Install Sensors form (**Figure 4-4**) presents the user with a list (on the left) of the available sensor models programmed into the DIINS software. The user (normally the maintenance engineer) selects and installs the sensors using this form to comply with the sensor configuration that is physically wired to the DIINS hardware. If the user makes a mistake or the sensor becomes unavailable, the installed sensor can also be removed using this form.

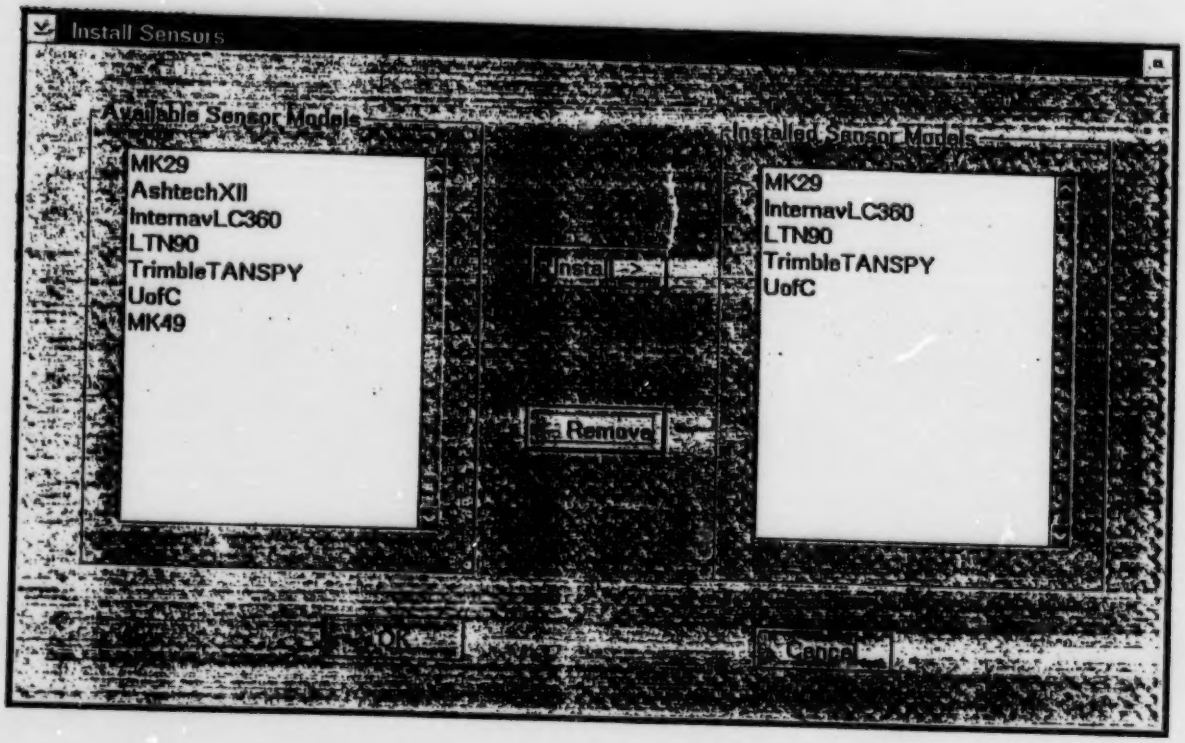

Figure 4-4 Install Sensors Form

The buttons on the Install Sensors form are listed in **Table 4-2**.

Table 4-2 Install Sensors Buttons

Button	Action
Install	Install sensors. Select one or more sensors from the available sensor list on the left. Then select this button. The selected sensors will be added to the list on the right.
Remove	Remove sensors. If one or more sensors in the installed sensor list are not installed, select the sensors from the list on the right and click this button. The selected sensors disappear from the installed sensor list.

4.1.7 Setting Sensor Lever Arms

Before using DIINS to provide a navigation solution it is necessary to inform DIINS of the locations of the sensors relative to the Reference Point. For the DIINS ADM, the Reference Point equals the Centre of Floatation.

Using the Lever Arms form shown in **Figure 4-5**, the operator selects the sensor for which data is to be reviewed/modified and enters new data as required.

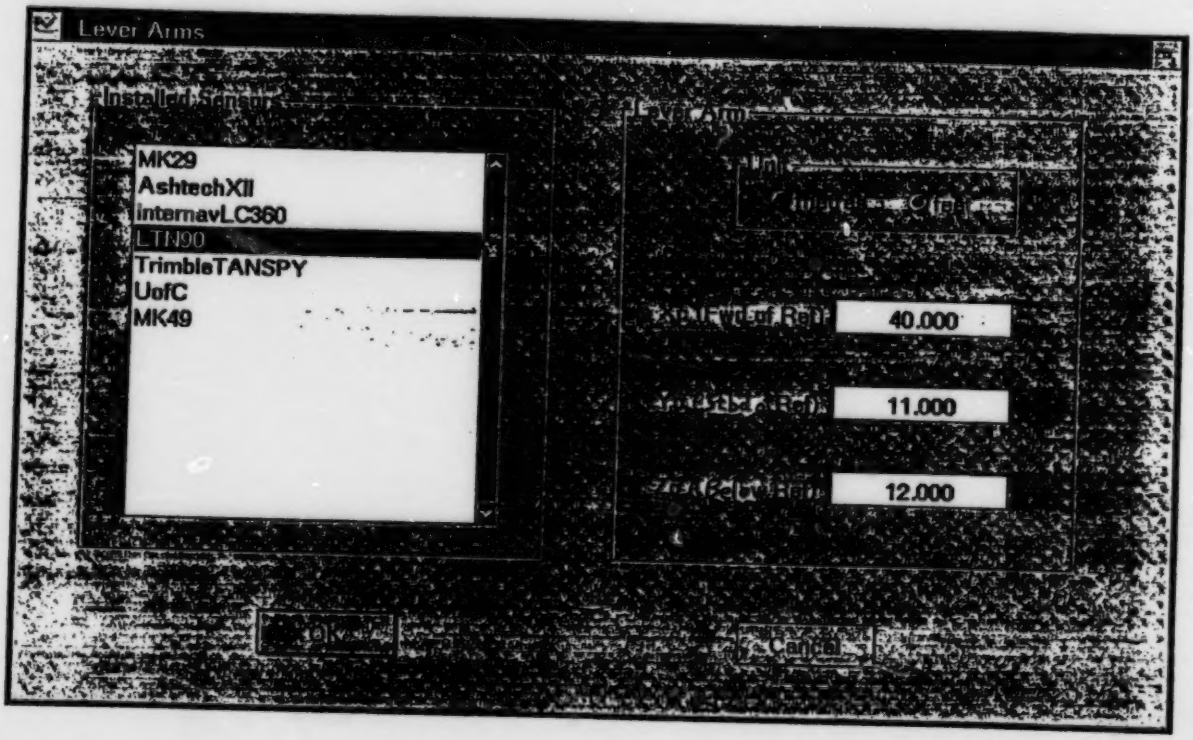

Figure 4-5 Lever Arms Form

4.1.7.1 Selecting Sensor

The user selects a sensor by using the mouse or arrow keys. The lever arm values of the selected sensor are displayed in the three data boxes on the right of the form. The units are indicated by the checked box in the Unit group.

4.1.7.2 Changing Lever Arm

To change the lever arm values, select the text fields by using the mouse button or tab key. Enter the desired values. Xc is the distance FORWARD of reference point (negative for Aft). Yc is the distance STARBOARD of reference point (negative for port). Zc is the distance BELOW the reference point (negative for Above). Note the figure is incorrect regarding Yc and Zc.

4.1.7.3 Changing Unit

To change the unit of the lever arm, select the radio button in the Unit group. The selected radio button will light. When the units are changed, the values are converted automatically. In **Figure 4-5**, for example, the lever arm of the sensor LTN90 is Xc = 40.0 feet, Yc = 11.0 feet, and Zc = 12.0 feet.

4.1.8 Setting Communication Parameters

DIINS communicates with SHINNADS and the other ship systems using serial communication interfaces, e.g. RS-232/422. The Communications Setup form (**Figure 4-6**) allows the user to review and modify the parameters associated with the communications channel for the selected sensor.

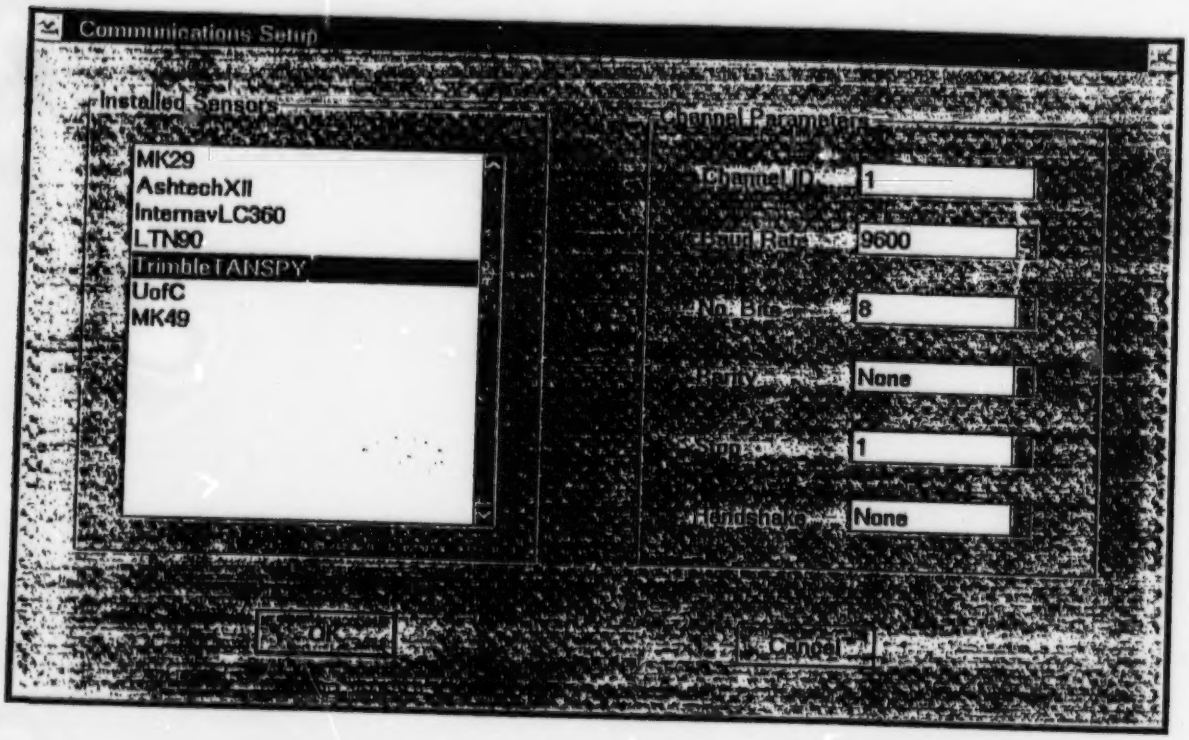

Figure 4-6 Communications Setup Form

4.1.8.1 Selecting Sensor

The user selects a sensor by clicking on one item in the installed sensor list or using the arrow keys to move through the list. The communication parameters of the selected sensor appear to the right of the form.

4.1.8.2 Changing Communication Parameters

The **Channel ID** can be changed by entering a string at the Channel ID text field. The current valid channel IDs are the numbers "1" to "8". Drop-down combo boxes provide selections for other communication parameters, which are listed in **Table 4-3**.

Table 4-3 Communication Parameters Combo Boxes

Combo Box	Description
Baud Rate	This combo box supplies a list of baud rates which can be set for the sensor. The selected baud rate is displayed in the box.

No. Bits	Using this combo box, the user selects the Number of Bits for the sensor communication. The selected value is displayed in the box.
Parity	This combo box supplies a list of the Parity values which can be set for the sensor. The selected value is displayed in the box.
Stop	This combo box supplies a list of the Number of Stop Bits. The Number of Stop Bits for the selected sensor is displayed in the box.
Handshake	This combo box supplies a list of Handshake modes. The Handshake mode for the selected sensor is displayed in the box.

4.1.9 Initializing Sensor Measurements

This form allows the system user to set up various initial values to be used by the Failure Detection and Isolation (FDI) algorithms to detect hard and soft failures. Each sensor measurement is associated with a sensor. Therefore, the list of installed sensors appears first, as shown in **Figure 4-7**. The user may proceed to sensor measurement initialization by selecting a sensor from the list.

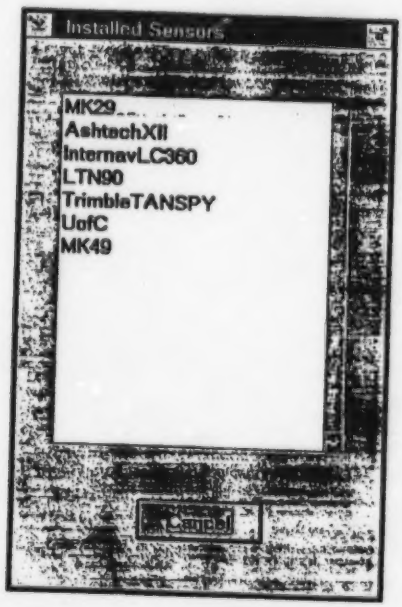

Figure 4-7 Installed Sensors List

4.1.9.1 Selecting Sensor

The user selects a sensor by clicking on one item in the installed sensor list or using the arrow keys to move through the list. Selection of a sensor opens an FDI Parameters form (**Figure 4-8**). All the measurements associated with the selected sensor are listed on the left side of the FDI Parameters form. The sensor model name is shown on the top of the list. For example, in **Figure 4-8**, the currently listed measurements belong to the sensor MK49.

Note that once an FDI Parameters form is open, the user cannot select another sensor until the current FDI Parameters form is closed.

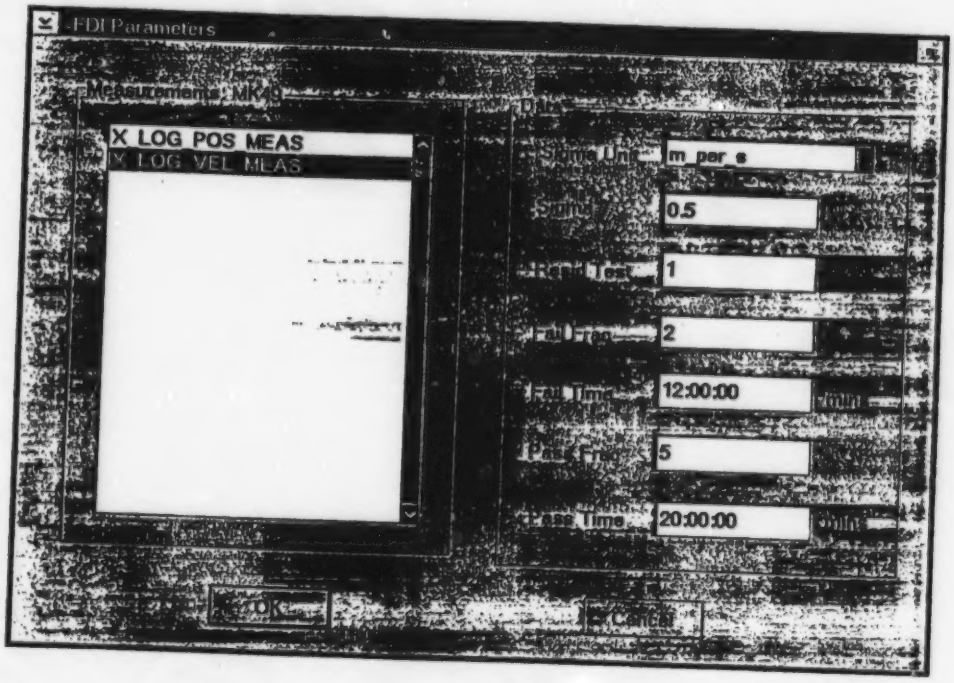

Figure 4-8 FDI Parameters Form

4.1.9.2 Selecting Measurement

The user selects a measurement in the same way as selecting a sensor. When a measurement item is selected, its parameter values appear on the right side of the form.

4.1.9.3 Changing Measurement Values

Each measurement has six data items: Sigma, Residual Test, Failure Fraction, Failure Time, Pass Fraction and Pass Time, which correspond to the six data fields on the form. The user may select a data field and enter the desired value.

4.1.9.4 Changing Sigma Unit

Depending on the type of the measurement, the Sigma may be length, angle, linear velocity, linear acceleration or angular velocity values. HCI determines the type of the sigma value and lists the available units for the sigma. The Sigma Unit combo box allows the user to select a desired unit. The currently used unit is displayed in the box. When the unit is changed, the sigma is converted and the new value is displayed in the Sigma data field. For example, in **Figure 4-8**, X_LOG_VEL_MEAS is a velocity measurement. The Sigma Unit combo box contains a list of velocity units. The current Sigma value is 0.5 m_per_s.

4.1.10 Setting Data Logging Parameters

The Data Logging form allows the user to select the various data items to be logged during the operation of DIINS. This form is shown in **Figure 4-9**.

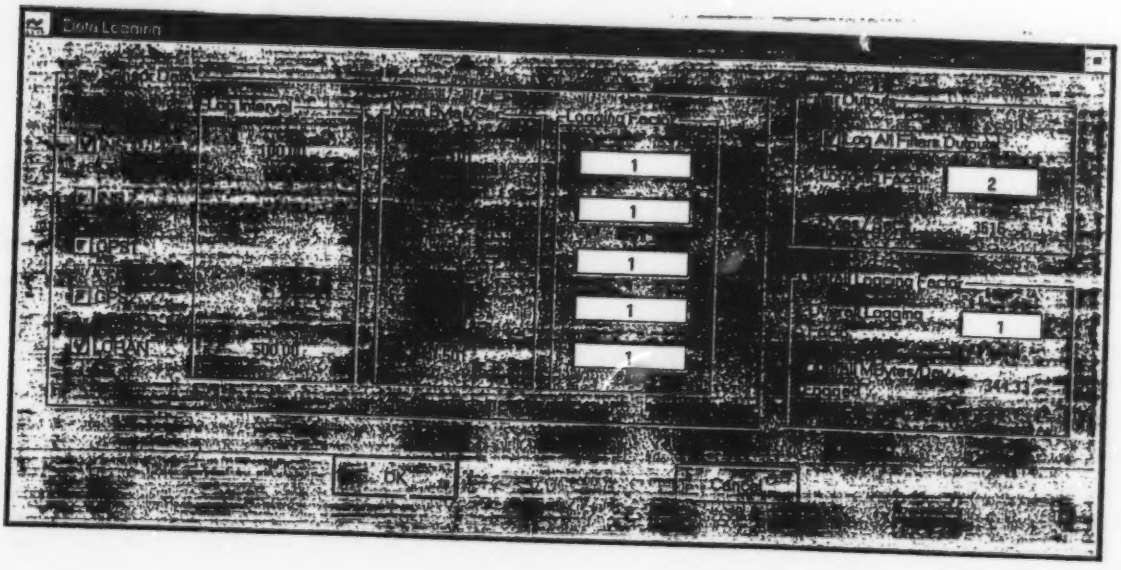

Figure 4-9 Data Logging Form

4.1.10.1 Selecting Sensors to Be Logged

The user uses the check boxes to select whether the sensor is to be logged or not. The check boxes are listed in **Table 4-4**. When checked, the check mark appears on the check box.

Table 4-4 Data Logging Check Boxes

Check Box	Description
INS1	When checked, the sensor type INS1 is logged. Otherwise, INS1 is not logged.
INS2	When checked, the sensor type INS2 is logged. Otherwise, INS2 is not logged.
GPS1	When checked, the sensor type GPS1 is logged. Otherwise, GPS1 is not logged.
GPS2	When checked, the sensor type GPS2 is logged. Otherwise, GPS2 is not logged.
LORAN	When checked, the sensor type LORAN is logged. Otherwise, LORAN is not logged.

In **Figure 4-9**, for example, INS1 and LORAN will be logged. If the sensor is not to be logged, its Log Interval and Nominal Bytes/Second display fields are left blank.

4.1.10.2 Changing Sensor Logging Factors

There are two logging rate scale factors available on the form. The "Overall Logging Factor" (bottom right) allows the user to adjust the overall logging rate by increasing the period at which the data is logged. In addition to the overall logging factor, each sensor has an individual Logging Factor that can be used to override the overall logging factor for the selected sensor. If the individual logging factors have been set and the overall logging factor is then modified, this resets all of the individual logging factors to the overall logging factor again.

The sensor logging factors are positive integers, indicating how often a data point should be saved. For example a "5" would cause every fifth data point to be saved.

4.1.10.3 Setting Filters Logging Parameters

The filter logging parameters are shown on the upper right of the form. The user may select to log or not to log the filter outputs by using the Log All Filters Outputs check box. When checked, the filter outputs are logged. The Log Factor edit box allows the user to change the period at which the filter outputs are logged.

The filter logging factor is a positive integer, indicating how often a data point should be saved. For example a "5" would cause every fifth data point to be saved.

4.1.10.4 Viewing the Number of Data to Be Logged

The text fields within the Nom Bytes/Sec group box indicates the number of bytes per second that would be logged for each sensor with the selected logging factor.

The Bytes/Sec text field within the Filter Outputs group box displays an approximation of the number of bytes per second currently being logged for the filters with the current filter logging parameters. Assuming that each filter has approximately 600 bytes to be logged over one sampling period, the number of filters is N_{filter} and the logging factor is M_{log}, the number of bytes per second for the filters outputs is $600*N_{filter}/(1.28*M_{log})$.

The Overall Mbytes/Day Logged text field on the lower right of the form shows the total number of bytes per day with the current sensor, filter and logging factor selections. This enables the user to determine how long the available storage volume for logging will last, or to be able to select the sensor and filter data to be logged to approximate a specific bytes/day requirement.

4.1.11 Setting High Rate Data Distribution

The Distribute High Rate Data form (**Figure 4-10**) allows the user to enable or disable the high rate data distribution and specify the distribution frequency. The user clicks the checkbox to enable (when the check mark shows) or disable (when the check mark is gone) the high rate data distribution. When enabled, the frequency field is also enabled and the user may enter a frequency value. The user selects the [OK] button to complete the change.

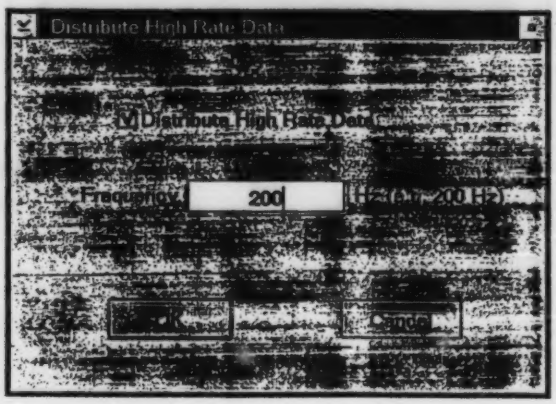

Figure 4-10 Distribute High Rate Data Form

4.1.12 Monitoring System Events

The Systems Status form (**Figure 4-11**) enables the DIINS user to monitor the processor load, selected filter and system events.

The % Processor Load text field shows the load currently being placed on the DIINS processor by the processing taking place in the current system configuration, e.g. which may include the operation of data logging. Upon receiving data from DIINS, this field is updated on-line.

The Selected Filter field indicates which filter is currently selected by the DIINS FDI for provision of the navigation solution.

The form displays a dynamically updated list of software exception events, FDI Log and Filter Log text messages. During normal system operation no software exception events should be shown in the list. The exceptions raised by the software may be due to either software or hardware failures. Appendix A lists the currently implemented exception messages.

The event list may contain up to 500 events. At any time the user may use the [ClearEventList] button to empty the list buffer.

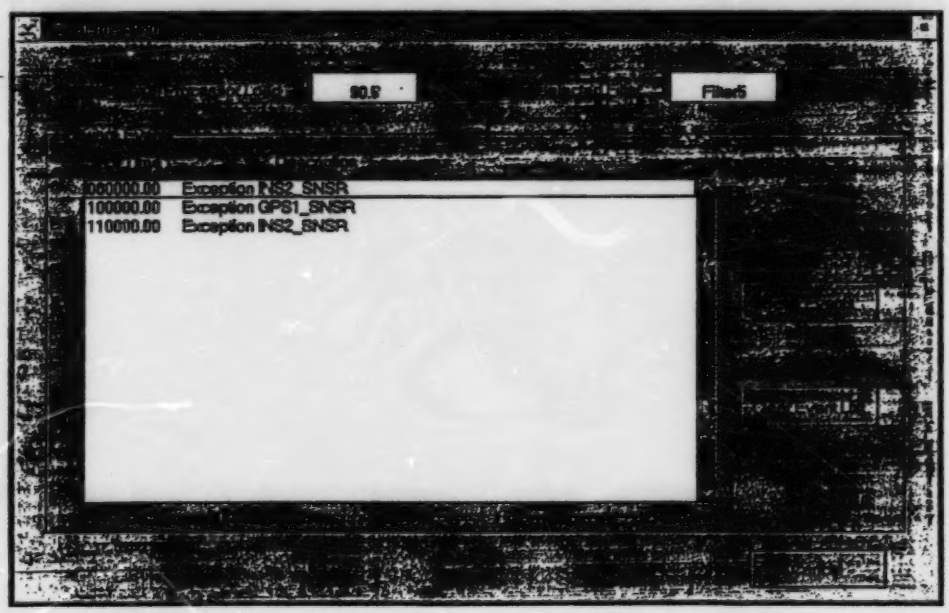

Figure 4-11 System Status Form

The Save Events button enables the user to save the events in the current list to a file. Selecting this button opens the open file dialog, shown in **Figure 4-12**. The default directory is set to the

current directory and the default file name extension is .evt. With this form, the user can select or enter a file name to which the events are saved.

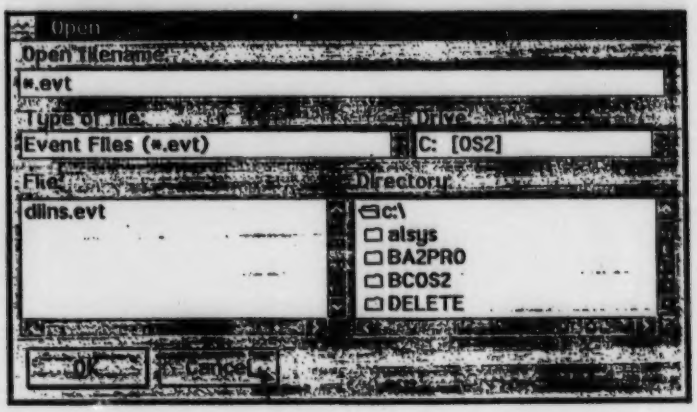

Figure 4-12 Open File Dialog

4.1.13 Saving Configuration Data

The [SaveConfigData] button on the HCI main window enables the user to save the current configuration data to a file. Selecting this button opens the open file dialog similar to that in **Figure 4-12**. The default directory is set to the current directory and the default file name extension is .cfg. Together with the [LoadConfigData] button, this button allows the user to save a set of satisfied configuration data and restore them in case of any mistakes.

4.1.14 Loading Configuration Data

The [LoadConfigData] button on the HCI main window enables the user to load the saved configuration data from a file. Selecting this button opens the open file dialog similar to that in **Figure 4-12**. The default directory is set to the current directory and the default file name extension is .cfg.

5. SHINNADS DISPLAY OF DIINS DATA

SHINNADS is an Electronic Chart and Display Information System that has been specially modified to operate in the navy environment. An interface to DIINS allows SHINNADS to accept and display the integrated navigation solution from the DIINS.

The DIINS screen is brought up on the SHINNADS display via the normal SHINNADS operator interface. The data are grouped to be shown in different subwindows.

5.1 DIINS Best Solution Subwindow

Table 5-1 describes the items in the DIINS Best Solution subwindow.

Table 5-1 DIINS Best Solution Items

Item	Description
Latitude	Best estimate of Latitude from the best Kalman filter, in a format of ddmm.mm
Longitude	Best estimate of Longitude from the best Kalman filter, in a format of ddmm.mm
Heading	Best estimate of True Heading from the best Kalman filter, in degrees
CMG	Best estimate of Course Made Good from the best Kalman filter, in degrees
SMG	Best estimate of Speed Made Good from the best Kalman filter, in m/s
Est.Error (95%)	95% radial position error estimate, in metres
N Std Dev.	North error estimate, standard deviation, in metres
E Std Dev.	East error estimate, standard deviation, in metres

5.2 DIINS Status Subwindow

Table 5-2 describes the items in the DIINS Status subwindow.

Table 5-2 Status Items

Item	Description
Status	DIINS overall health status: 1 = At least one valid integrating filter 0 = No valid INS or Kalman filter. Best single sensor is being output
Currently Integrating	
INS1	Sensor status: 1 = Used in current filter and FDI status is good 0 = Not used in current filter and FDI status is bad
INS2	
GPS1	
GPS2	
Loran	

5.3 RAW DATA Subwindows

Table 5-3 describes items in the RAW DATA subwindows and indicates to which sensors the item is applicable.

Table 5-3 Raw Data Items

Sensor Data Item	Description	Sensors
Latitude	Raw latitude data from the sensor, in a format of ddmm.mm	INS1, INS2, GPS1, GPS2, Loran
Longitude	Raw latitude data from the sensor, in a format of ddmm.mm	INS1, INS2, GPS1, GPS2, Loran
Heading	Raw heading data from the sensor, in degrees	INS1, INS2
SMG	Course Made Good data from the sensor, in km/hr	INS1, INS2, GPS1, GPS2
CMG	Speed Made Good data from the sensor, in degrees	INS1, INS2, GPS1, GPS2
Status	GPS1 and GPS2: 0 = Invalid 1 = Valid INS1, INS2 and Loran: A = Valid V = Invalid	INS1, INS2, GPS1, GPS2, Loran

5.4 Time

The TIME item shows the DIINS Time of Position, in hhmmss.ss format.

6. NOTES

6.1 List of Acronyms

ADM	Advanced Development Model
CCA	Computer Card Assembly
CPU	Central Processing Unit
CSC	Computer Software Component
CSCI	Computer Software Configuration Item
DIINS	Dual Inertial Integrated Navigation System
DREO	Defence Research Establishment Ottawa
ECDIS	Electronic Chart and Display Information System
FDI	Failure Detection and Isolation
GPS	Global Positioning System
HCI	Human Computer Interface
INS	Inertial Navigation System
OSL	Offshore Systems Limited
SDD	Software Design Document

APPENDIX A – LIST OF EXCEPTIONS MESSAGES

Currently no exception messages are sent to the HCI.

APPENDIX B – DESCRIPTION OF INTERFACE PROVIDING DIINS DATA TO SHINNADS

1. **Introduction**: An RS232 port (default port 3) on the DIINS ADM will be used to provide serial data to SHINNADS. This document describes the output of the DIINS ADM, software version **3.02**.

2. **Physical:** The pin-outs on the RS-232 DB9 Male Connector are standard:

1.	DCD	6.	DSR
2.	RXD	7.	RTS
3.	TXD	8.	CTS
4.	DTR	9.	NC
5.	GND		

3. **Communication Parameters**:- 19,200 baud,
   - 8 data bits, no parity, 1 stop (8N1)
   - software handshake (xon, xoff).

4. **ASCII Output Sentences**: The DIINS ADM data output will be contained in ten data sentences as follows:

a) DIINS position ($INGLL):
- Latitude
- Longitude
- time
- status
- checksum

b) DIINS heading ($INHDT):
- heading
- checksum

c) DIINS velocity, error estimate and FDIR status ($PDRO1):
- track angle
- ground speed
- north position standard deviation estimate
- east position standard deviation estimate
- 95 percentile radial error estimate
- FDIR Status
- checksum

d) DIINS attitude ($PDRO2):
- heading
- pitch
- roll

- checksum

e) GPS (GPS_1 , GPS_2) position ($GPGGA):
- time
- Latitude
- Longitude
- quality
- HDOP
- checksum

Note: GPS_1 is Trimble P(Y), GPS_2 is DGPS

f) GPS (GPS_1 , GPS_2) velocity ($GPVTG):
- track angle
- ground speed
- checksum

g) INS ($Mk29_1$, $Mk29_2$) position ($HEGLL):
- Latitude
- Longitude
- time
- status
- checksum

h) INS ($Mk29_1$, $Mk29_2$) heading ($HEHDT):
- heading
- checksum

i) INS ($Mk29_1$, $Mk29_2$) velocity ($HEVTG):
- track angle
- ground speed
- checksum

j) Loran-C (LC360) position ($LCGLL):
- Latitude
- Longitude
- time
- status
- checksum

5. **Data Sentence Details**: The encapsulation of these data sets will conform to NMEA 0183 (version 2.00) where possible.

a) DIINS position data is contained in the pre-defined NMEA 0183 (version 2.00) sentence GLL. The Talker Identifier Mnemonic in this case will be IN, for Integrated Navigation.

$INGLL,llll.ll,a,yyyyy.yy,a,hhmmss.ss,A *hh<CR><LF>

llll.ll,a	WGS84 Latitude ddmm.mm,N/S
yyyyy.yy,a	WGS84 Longitude dddmm.mm,E/W
hhmmss.ss	DIINS Time of Position
A	Status (A=Valid, V=Not valid)

hh	checksum

Example: $INGLL,4520.824,N,07553.321,W,232.04,A*38

b) DIINS heading data is contained in the NMEA 0183 (version 2.00) sentence HDT:

$INHDT,x.x,T*hh<CR><LF>

x.x,T	Heading (degrees True from North, WGS84)
hh	checksum

Example: $INHDT,113.165,T*09

c) DIINS Velocity, Error estimate and Status: Unfortunately, the predefined NMEA sentence structures do not include covariance information (which is an important output of integrated navigation systems), and do not provide true velocity in a reasonable format. Therefore, a custom sentence structure is defined to contain these items:

$PDRO1,x.x,T,x.x,M,x.x,N,x.x,E,x.x,C,c--c*hh<CR><LF>

where the manufacturer's Mnemonic code is DRO for Defence Research Ottawa, the 1 distinguishes this from other proprietary sentences.

x.x,T	Track angle or CMG (degrees True from North, WGS84)
x.x,M	Speed over ground or SMG (m/s)
x.x,N	North error estimate, standard deviation (meters)
x.x,E	East error estimate, standard deviation (meters)
x.x,C	95% radial position error estimate (meters)
c---c	DIINS FDIR status word (character field)
hh	checksum

The DIINS **FDIR status word** (c---c) is a 7 character field that can be used to determine the overall health of DIINS, the current status of the individual sensors, and which DIINS internal filter is presently being used. The meaning of each digit is described here: From left to right: (Character 1 -> 1111012 <- Character 7)

Character

1 INS1 Status
- 1= Used in current filter and FDI status is good
- 0= Not used in current filter or FDI status is bad

2 INS2 Status
- 1= Used in current filter and FDI status is good
- 0= Not used in current filter or FDI status is bad

3 GPS1 Status
- 1= Used in current filter and FDI status is good
- 0= Not used in current filter or FDI status is bad

4 GPS2 Status
- 1= Used in current filter and FDI status is good

0= Not used in current filter or FDI status is bad

5 Loran Status
1= Used in current filter and FDI status is good
0= Not used in current filter or FDI status is bad

6 DIINS Overall Health
1=At least one valid integrating filter,
0=No valid INS or Kalman filter. Best Single sensor is being output

7 Which Filter is being used
1 through F (hex)

Example: $PDRO1,51.959,T,0.222,M,10.2,N,10.2,E,24.9,C,1001112*55

d) DIINS Attitude: The predefined NMEA sentence structures do not include attitude information. Therefore, a second proprietary sentence structure is defined:

$PDRO2,x.x,x.x,x.x*hh<CR><LF>

where from left to right,

x.x,	heading (deg), deg from North True
x.x,	pitch (deg), pitch up positive
x.x	roll (deg), roll right (starboard down) positive

Example: $PDRO2,113.165,-0.003,0.006*3D

e) GPS Position: For the GPS data, the GGA sentence will be used (possibly with null fields).

$GPGGA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,q,nn,d.d,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF>

hhmmss.ss	UTC Time of Position
llll.ll,a	WGS84 Latitude ddmm.mm,N/S
yyyyy.yy,a	WGS84 Longitude dddmm.mm,E/W\
q,	GPS Quality
	0 = Fix not available or not valid (From sensor DCT)
	1 = GPS fix valid
	2 = DGPS SPS mode, fix valid **[May not be present]**
	3 = GPS PPS mode, fix valid **[May not be present]**
nn,	number of satellites in view **[May be null]**
d.d	HDOP
(Rest of fields may be null)	
hh	checksum

Example: $GPGGA,152.35,4520.824,N,07553.323,W,1,,1.0,,,,,*58

f) GPS Velocity: For the GPS velocity data the VTG sentence will be used:

$GPVTG,x.x,T,x.x,M,x.x.N,x.x,K*hh<CR><LF>

x.x,T	Track angle or CMG (degrees True from North, WGS84)
x.x,M	Track angle or CMG (degrees Magnetic) **[May be Null]**
x.x,N	Speed over ground (knots) **[May be Null]**
x.x,K	Speed over ground (km/hr)
hh	checksum

Example: $GPVTG,19.000,T,,,,,0.300000,K*46

NOTE 1: To identify which GPS the $GPGGA and $GPVTG data comes from (i.e. GPS1 or GPS2), each pair of these messages will always be preceded with the appropriate STN sentence:

$GPSTN,xx*hh<CR><LF>

where xx is either 01 or 02.

NOTE 2: The $GPSTN, $GPGGA, $GPVTG sentences will always appear as a set corresponding to one or the other of the GPSs. That is, there will be a set of sentences in the order ($GPSTN,01 ... $GPGGA .... GPVTG) corresponding to GPS1 and another set ($GPSTN,02 ... $GPGGA .... $GPVTG) corresponding to GPS2. These sets of sentences will not be intermixed with each other, although other sentences (particularly the high rate $PDR02) may be intermixed with them.

g) INS Position: The Inertial position data will be contained in the approved GLL sentence format. There is no INS "Talker Mnemonic", however, HE comes close.

$HEGLL,llll.ll,a,yyyyy.yy,a,hhmmss.ss,A*hh<CR><LF>

llll.ll,a	Latitude ddmm.mm,N/S
yyyyy.yy,a	Longitude dddmm.mm,E/W
hhmmss.ss	DIINS Time of Position
A	Status (A=Valid, V=Not valid) from sensor DCT
hh	checksum

Example: $HEGLL,4520.910,N,07553.041,W,232.33,A*35

h) INS Heading: The Inertial heading data will be contained in the HDT sentence format:

$HEHDT,x.x,T*hh<CR><LF>

x.x,T	Heading (degrees True from North)

hh	checksum

Example: $HEHDT,111.429,T*0C

i) INS Velocity: The Inertial course and speed data will be contained in the approved VTG sentence format:

$HEVTG,x.x,T,x.x,M,x.x.N,x.x,K*hh<CR><LF>

x.x,T	Track angle or CMG (degrees True from North, WGS84)
x.x,M	Track angle or CMG (degrees Magnetic) **[May be Null]**
x.x,N	Speed (knots) **[May be Null]**
x.x,K	Speed (km/hr)
hh	checksum

Example: $HEVTG,56.602,T,,,,,1.577094,K*59

NOTE 1: To identify which INS the $HEGLL, $HEHDT and $HEVTG data comes from (i.e. INS1 or INS2), each set of these messages will always be preceded with the appropriate STN sentence:

$HESTN,xx*hh<CR><LF>

where xx is either 01 or 02.

NOTE 2: The $HESTN, $HEGLL, $HEHDT, $HEVTG sentences will always appear as a set corresponding to one or the other of the INSs. That is, there will be a set of sentences in the order ($HESTN,01 ... $HEGLL .... $HEHDT...$HEVTG) corresponding to INS1 and another set ($HESTN,02 ... $HEGLL .... $HEHDT...$HEVTG) corresponding to INS2. These sets of sentences will not be intermixed with each other, although other sentences (particularly the high rate $PDR02) may be intermixed with them.

j) Loran-C position data will be contained in the approved GLL sentence format:

$LCGLL,llll.ll,a,yyyyy.yy,a,hhmmss.ss,A*hh<CR><LF>

llll.ll,a	WGS84 Latitude ddmm.mm,N/S
yyyyy.yy,a	WGS84 Longitude dddmm.mm,E/W
hhmmss.ss	DIINS Time of Position
A	Status (A=Valid, V=Not valid) from Sensor DCT
hh	checksum

6. Output Rates:

INS sentences ($HEGLL(5.g), $HEHDT(5.h) and $HEVTG(5.i)) are output every 1.28 seconds.

DIINS sentences ($INGLL(5.a), $INHDT(5.b), $PDRO1(5.c)) are output at an integer multiple of 1.28 seconds (ranging from 1 to 7 depending on the configuration).

Attitude data sentence ($PDRO2(5.d)) is output every 80 milliseconds.

GPS ($GPGGA(5.e), $GPVTG(5.f)) and Loran ($LCGLL(5.j)) sentences will be output as available (approximately every second).

7. **Sample Output**: The following is a sample of DIINS output (includes all but LCGLL):

```
$PDRO2,-113.158,-0.007,0.004*35
$GPSTN,01*73
$GPGGA,720.38,4520.821,N,07553.330,W,1,,0.0,,,,,*50
$GPVTG,-160.230,T,,,,,0.123433,K*52
$INGLL,4520.822,N,07553.328,W,719.21,A*3C
$INHDT,-113.158,T*07
$PDRO1,-20.577,T,0.018,M,2.7,N,2.7,E,6.5,C,1011112*48
$PDRO2,-113.158,-0.007,0.001*30
$PDRO2,-113.158,-0.007,0.001*30
$PDRO2,-113.158,-0.009,0.004*3B
$PDRO2,-113.158,-0.007,0.001*30
$PDRO2,-113.158,-0.001,0.004*33
$PDRO2,-113.158,-0.007,0.001*30
$HESTN,02*6A
$HEGLL,4520.923,N,07553.085,W,720.78,A*34
$HEHDT,-111.434,T*00
$HEVTG,104.036,T,,,,,0.089484,K*6E
$PDRO2,-113.163,-0.007,0.004*3D
$HESTN,01*69
$HEGLL,4522.143,N,07551.944,W,720.49,A*3C
$HEHDT,-113.148,T*0C
$HEVTG,42.310,T,,,,,1.526093,K*59
$PDRO2,-113.158,-0.009,0.001*3E
$GPSTN,02*70
$GPGGA,721.09,4520.821,N,07553.327,W,1,,0.9,,,,,*5C
$GPVTG,29.900,T,,,,,0.080000,K*47
$PDRO2,-113.163,-0.007,0.004*3D
$PDRO2,-113.152,-0.004,0.004*3C
$PDRO2,-113.163,-0.004,0.004*3E
$PDRO2,-113.158,-0.001,0.001*36
$PDRO2,-113.158,-0.007,0.001*30
$PDRO2,-113.158,0.001,0.004*1E
$PDRO2,-113.147,-0.007,0.001*3E
$PDRO2,-113.163,-0.001,0.001*3E
$GPSTN,01*73
$GPGGA,721.37,4520.821,N,07553.330,W,1,,0.0,,,,,*5E
$GPVTG,169.779,T,,,,,0.133386,K*76
$PDRO2,-113.158,-0.007,0.001*30
$PDRO2,-113.158,-0.007,0.001*30
$PDRO2,-113.158,-0.004,0.001*33
$GPSTN,02*70
$GPGGA,722.09,4520.821,N,07553.327,W,1,,0.9,,,,,*5F
$GPVTG,0.000,T,,,,,0.010000,K*7C
$PDRO2,-113.158,-0.004,0.001*33
$PDRO2,-113.158,-0.004,0.004*36
$PDRO2,-113.158,-0.001,0.001*36
$HESTN,02*6A
$HEGLL,4520.923,N,07553.085,W,722.06,A*3F
$HEHDT,-111.434,T*00
$HEVTG,108.435,T,,,,,0.091508,K*69
$PDRO2,-113.158,0.001,0.001*1B
$HESTN,01*69
$HEGLL,4522.144,N,07551.943,W,721.77,A*30
```

```
$HEHDT,-113.143,T*07
$HEVTG,42.494,T,,,,,1.520751,K*5D
$PDRO2,-113.158,-0.007,0.001*30
$PDRO2,-113.158,-0.004,0.001*33
$PDRO2,-113.158,-0.004,0.004*36
$PDRO2,-113.158,-0.007,0.004*35
$PDRO2,-113.152,-0.004,0.001*39
$PDRO2,-113.158,-0.001,0.001*36
$PDRO2,-113.152,-0.004,0.004*3C
$PDRO2,-113.158,-0.904,0.004*36
$GPSTN,01*73
$GPGGA,722.38,4520.820,N,07553.330,W,1,,,0.0,,,,,*53
$GPVTG,-177.265,T,,,,,0.133559,K*58
$PDRO2,-113.158,-0.004,0.004*36
$PDRO2,-113.163,-0.007,0.001*38
$PDRO2,-113.158,-0.007,0.001*30
$GPSTN,02*70
$GPGGA,723.09,4520.821,N,07553.327,W,1,,,0.9,,,,,*5E
$GPVTG,0.000,T,,,,,0.040000,K*79
$PDRO2,-113.158,-0.004,0.001*33
$PDRO2,-113.163,-0.001,0.001*3E
$PDRO2,-113.158,-0.009,0.001*3E
$PDRO2,-113.147,-0.004,0.001*3D
$PDRO2,-113.158,-0.007,0.001*30
$HESTN,02*6A
$HEGLL,4520.923,N,07553.085,W,723.34,A*3F
$HEHDT,-111.429,T*0C
$HEVTG,104.036,T,,,,,0.089484,K*6E
$HESTN,01*69
$HEGLL,4522.144,N,07551.943,W,723.04,A*36
$HEHDT,-113.143,T*07
$HEVTG,42.310,T,,,,,1.526093,K*59
$GPSTN,01*73
$GPGGA,723.38,4520.820,N,07553.330,W,1,,,0.0,,,,,*52
$GPVTG,171.984,T,,,,,0.097134,K*77
$PDRO2,-113.158,-0.007,0.001*30
$PDRO2,-113.158,-0.007,0.004*35
$PDRO2,-113.163,-0.004,0.001*3B
$PDRO2,-113.158,-0.004,0.001*33
$PDRO2,-113.158,-0.009,0.004*3B
$PDRO2,-113.152,-0.007,0.001*3A
$PDRO2,-113.163,-0.007,0.004*3D
$PDRO2,-113.158,-0.001,0.004*33
$PDRO2,-113.158,-0.009,-0.002*10
$GPSTN,02*70
$GPGGA,724.09,4520.821,N,07553.327,W,1,,,0.5,,,,,*59
$GPVTG,0.000,T,,,,,0.010000,K*7C
$INGLL,4520.822,N,07553.328,W,723.04,A*32
$INHDT,-113.158,T*07
$PDRO1,-17.549,T,0.020,M,2.8,N,2.8,E,6.8,C,1011112*47
$PDRO2,-113.158,-0.009,0.001*3E
$PDRO2,-113.163,-0.007,0.001*38
$PDRO2,-113.158,-0.007,0.004*35
$GPSTN,01*73
$GPGGA,724.40,4520.823,N,07553.330,W,1,,,0.0,,,,,*59
$GPVTG,160.056,T,,,,,0.051177,K*7C
```

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (the name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Establishment sponsoring a contractor's report, or tasking agency, are entered in section 8.)

Prior Data Sciences Ltd.
240 Michael Cowpland Drive
Kanata ON K2M 1P6

2. SECURITY CLASSIFICATION (overall security classification of the document, including special warning terms if applicable)

UNCLASSIFIED

3. TITLE (the complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S,C or U) in parentheses after the title.)

User's Manual for the DIINS Human-Computer Interface (U)

4. AUTHORS (Last name, first name, middle initial)

Xu, H., Davis, T.

5. DATE OF PUBLICATION (month and year of publication of document)

30 Mar 1999

6a. NO. OF PAGES (total containing information. Include Annexes, Appendices, etc.)

34

6b. NO. OF REFS (total cited in document)

3

7. DESCRIPTIVE NOTES (the category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Technical Report

8. SPONSORING ACTIVITY (the name of the department project office or laboratory sponsoring the research and development. Include the address.)

Defence Research Establishment Ottawa
Department of National Defence
Ottawa ON K1A 0Z4

9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant)

Project 1bd17

9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written)

W7714-8-0211

10a. ORIGINATOR'S DOCUMENT NUMBER (the official document number by which the document is identified by the originating activity. This number must be unique to this document.)

99-0067-K DRES CONTRACTOR REPORT 1999-113

10b. OTHER DOCUMENT NOS. (Any other numbers which may be assigned this document either by the originator or by the sponsor)

11. DOCUMENT AVAILABILITY (any limitations on further dissemination of the document, other than those imposed by security classification)

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This HCI User's manual applies to the Human Computer Interface (HCI) associated with the Dual Inertial Integrated Navigation System (DIINS) Advanced Development Model (ADM). This manual provides the procedures for operating the DIINS HCI and describes the intended use of the system. In addition this manual also describes the SHINNADS display and the DIINS-SHINNADS interface.

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DIINS
Navigation Systems
Navigation Software
Software Design
User Interface